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THE PARSONS STEAM TURBINE.

The Evolution of the Parsons Steam Turbine. By Alex. Richardson. Pp. xix+264+173 plates in the text. (London: Offices of *Engineering*, 1911.) Price 21s.

IN this volume there is contained an authentic record of steps taken in the development of a great invention. Lord Kelvin once described the work done by the Hon. Sir Charles Parsons in connection with the steam turbine as ranking in importance with the work of James Watt. The council of the Royal Society of Arts in awarding the Albert medal for 1911 to Sir Charles Parsons, for his experimental researches into the laws governing the efficient action of steam in engines of the turbine type, and for his invention of the reaction type of turbine, stated that by means of its practical applications the production of mechanical power had been cheapened, economy of fuel and higher speeds had been obtained in steamships, and the problem of rotary engines, which long had baffled many other inventors, had been solved. This expression of opinion by a council which includes many eminent engineers and physicists will command universal assent: it also emphasises the value attaching to the record of research and achievement which has been undertaken and completed by the author of this book. The principal facts were already available, having been published from time to time in the Proceedings of engineering societies and in engineering journals. But it is equally true that by collecting and arranging such materials the author has done a useful piece of work, and done it well. Not merely has he told the story in an interesting way, but he has secured the aid of Sir Charles Parsons and several of his colleagues, and has thus made the record complete, adding many new facts. One characteristic of the book deserves special mention: its style and method will enable readers to master the main steps in the development of the steam turbine, even though their knowledge of engineering is small. On the other hand, skilled mechanical engineers can find therein a wealth of illustration and a mass of valuable data obtained by Sir Charles Parsons and his assistants in their long and varied experimental researches.

It scarcely seems credible, but it is the fact, that so lately as 1884 Sir Charles Parsons began work on his first steam turbines, or that it was ten years later before trials were made with the first steamship driven by turbine machinery. During the earlier period progress was naturally slow: many difficulties had to be overcome, and outside or accidental causes of delay occurred. The inventor was not daunted by these difficulties, and he fortunately obtained support from friends who had confidence in his ability to face and solve problems which had baffled previous investigators. Sir Charles Parsons, like many other inventors, discovered that although many previous attempts had been made to construct steam turbines, little exact or trustworthy data had been put on record by his predecessors. Consequently it became necessary for him to arrange and undertake further and costly experiments. The system which had previously found most favour with his predecessors was that known as the "impulse type" of turbine, in which rotary motion was produced by the impact of steam jets on suitably shaped cavities situated at the periphery of revolving wheels, or by the reaction of steam-jets issuing into the atmosphere. Sir Charles Parsons originated the idea of splitting up the fall in steam pressure, by employing a great number of wheels or turbines placed in series. To quote Mr. Richardson's words, Sir Charles Parsons made "the assumption that in each turbine the action would approximate to that in a turbine using an incompressible fluid such as water, and that the aggregate of such simple turbines, which together constituted the complete machine, would give an efficiency approximating to that obtained in water turbines."

This fundamental assumption proved to be accurate; but when the fact had been established its embodiment in successful machines which were individually of large power demanded great skill and patient experiment. Unfortunately, after the first reaction turbines had been made and proved successful, difficulties of a business nature interfered for some time with the development of the system. Sir Charles Parsons then introduced turbines of the "radial flow" type instead of the longitudinal flow type with which his name will ever be associated. The first turbine was produced in 1884 and was applied to the generation of electricity, the design of the dynamo being modified by the inventor so that it might be suitable for association with turbines running at very high rates of revolution. These early turbo-generators were of comparatively small power and were relatively wasteful in steam consumption, although in their mechanical details they were the pioneers of the enormously powerful machines now in use on land in electro-generating stations. In 1885 a turbo-generator of four-kilowatts power required 200 lb. of steam per kilowatt-hour. In 1910 turbo-generators of 5000 kilowatts were produced by Sir Charles Parsons, and the steam consumption per kilowatt-hour was but little more than 13 lb. Limits of space prevent any detailed explanation being given of the successive improvements which have led to this remarkable economy in steam consumption; but readers desirous of tracing these steps will find every information in the pages of the volume under review.

In the application of the Parsons steam turbine to ship propulsion even more remarkable progress has been made. The first vessel (the famous *Turbinia*), completed in 1897, was a hundred feet long and weighed about forty-four tons; her engines developed 2300 horse-power, and her speed was $32\frac{3}{4}$ knots for runs of short duration. Ten years later the great Cunard trans-Atlantic steamships *Mauretania* and *Lusitania* were driven by turbine machinery developing 74,000 horse-power, the length of the vessels being about 785 feet, their weight 40,000 tons; and the mean speed on their fastest trans-Atlantic voyages 26 knots. The latest armoured cruisers of the *Lion* class in the Royal Navy furnish the most notable illustra-

tions of the application of the Parsons steam turbine to warships: their engines will develop more than 70,000 horse-power, and are estimated to drive vessels weighing 26,400 tons at speeds approaching 30 knots per hour for short periods and from 26 to 27 knots for great distances. A table in the book shows that on June 30, 1910, the Parsons type of turbine had been applied to 333 steamships, and that their aggregate horse-power exceeded 4,700,000. The first order for a turbine destroyer was given by the British Admiralty in 1899; the first merchant steamer fitted with turbine machinery was built by Messrs. Denny in 1901; and this simple statement of facts indicates the unprecedented progress which has been made by the new type of marine steam engine. That progress proceeds at an accelerated rate; and in July, 1911, 378 steam vessels, with an aggregate of more than 5,800,000 horse-power in Parsons turbines, had been built or were building.

As time has passed and experience has been gained modifications and improvements have naturally been made by the inventor. It becomes obvious from the story told by Mr. Richardson that from first to last broad views, original research, and readiness to test the relative merits of alternative arrangements, have marked the work done by Sir Charles Parsons. The mechanical ingenuity which has been displayed by him in the details of designs for steam turbines is illustrated in many ways, and no one can fail to be impressed by the mastery of fundamental principles affecting the economic use of steam in engines of the turbine type displayed by him, and the skill shown in the design of mechanical engineering details, as well as processes of manufacture, which have been no less essential to the success of the new invention. In the marine steam turbine the principles upon which economy and efficiency depend are, of course, identical with those which hold good in steam turbines applied for land purposes; but in connection with ship propulsion the designer has not only to take into account the efficient use of steam in turbines, but the general propulsive efficiency secured by the combination of efficient turbines with suitable screw propellers driven by the turbines. In marine steam turbines it is consequently found necessary to accept lower rates of revolution than can be applied with advantage in land turbines because a very rapid rate of rotation tends to diminished propeller-efficiency. This was one of the most serious problems which had to be faced in the design and construction of the *Turbinia*; its solution occupied a long period, and led to many modifications in that remarkable vessel before success was finally achieved and the revolution in marine steam engines above described was made possible.

Great differences exist in the conditions of service of various classes of ships, and demand different designs of propelling machinery. Hitherto the turbine has been used almost entirely in vessels of high speed, but its use in vessels of moderate or low speed is now being considered. There also Sir Charles Parsons has done pioneer work and has taken the lead in producing practical examples. A cargo steamer of good type (the *Vespasian*) has been purchased, her reciprocating engine has been removed, and geared turbines have been fitted instead. These turbines run much faster than the propeller shafts, so that both the turbines and the screw propellers can be given high efficiency. A long period of working in actual service, as well as measured mile trials, have shown a considerable gain in economy and cargo capacity which was well worth having in cargo vessels even of low speed. Another arrangement suitable for vessels of the "intermediate" type—in which large passenger accommodation is combined with a great capacity for carrying cargo and moderate speed—is known as the "combination system." Low-pressure turbines are associated with reciprocating engines in such vessels, and the expansion of the steam can thus be carried much further than in engines of the reciprocating type. In the *Olympic* and *Titanic*, the largest vessels at present afloat in the mercantile marine, this combination system has been applied, and it had previously proved completely successful in vessels trading to Australia and Canada. These are but a few of the examples of the variety of the applications of the steam turbine in marine propulsion which are illustrated in this book; and other applications to mine ventilation, blast furnace operations, and other services are also described. The volume is handsomely produced and beautifully illustrated.

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SYSTEMATIC BOTANY.

Handbuch der systematischen Botanik. By Prof. R. R. v. Wettstein. Zweite Auflage. 1 Hälfte. Pp. 424. Price 20 marks. 2 Hälfte. Pp. viii+425–915. Price 24 marks. (Leipzig und Wien: F. Deuticke, 1910–11.)

THE first edition of this work appeared in 1901, and during the decade that has elapsed since, important advances have been made in the investigation of many groups in the vegetable kingdom, more especially in the Schizophyta and the Gymnospermæ. The first part comprises the Cryptogams and Gymnosperms, preceded by a general introduction of some fifty pages, in which the more recent discoveries and theories are discussed, explained, or mentioned. As the title indicates, the work is entirely devoted to systematic botany, and it may be added that it is not intended for the beginner, but for students already fairly well versed in the rudiments of the science.

The main object has been to construct, or rather to improve, a classification on phylogenetic principles. It is now generally admitted that it is impossible to give expression to this in a linear arrangement, especially as a monophyletic development can no longer be sustained. On this point Dr. Wettstein is very decided. He accepts it as probable, however, that the more highly organised plants—the Cormophytes—are of monophyletic descent, though it cannot be claimed that this point has been settled. On the other hand, he considers that it is beyond doubt that the so-called Thallophytes include types of very different origin. Consistent with these views, Wettstein discriminates seven "Stämme," or lines of development, namely, (i) Myxophyta; (ii) Schizophyta; (iii) Zygo-